

Embeddable Chemical Sensors Enable SLI and Advanced PPT

Brent J. Lutz, Synkera Technologies Inc.

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Abstract

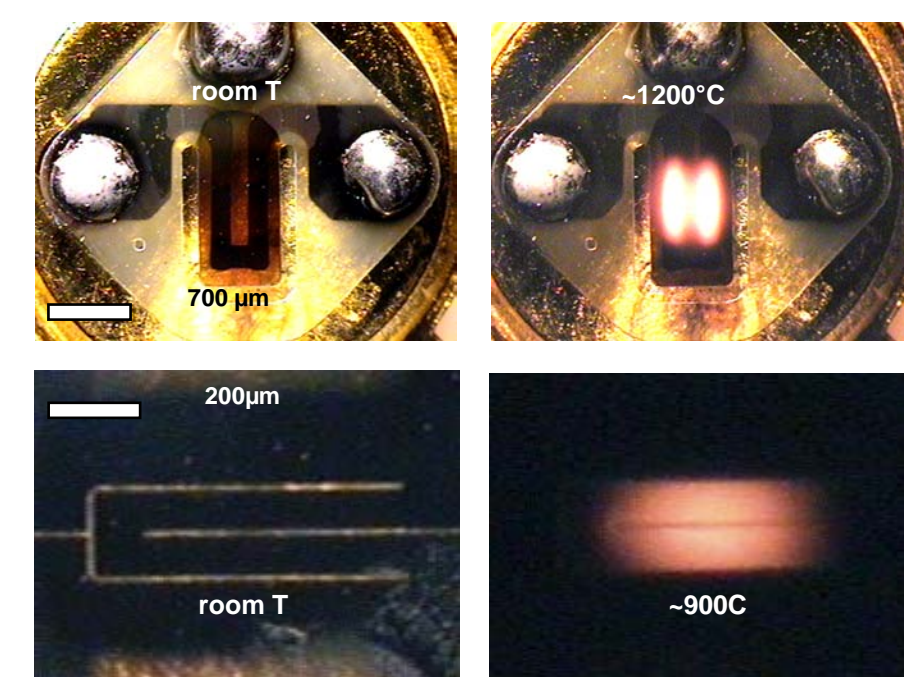
Synkera has developed MikroKera™, a new line of ultra-small, low-power, low-cost chemical sensors. These sensors enable advances in the functionality of PPT, leading to improved worker health and safety.

One example of Synkera sensors employed for advanced PPT is active SLI in respirators. MikroKera™ sensors are small and low-power enough to be embedded in powered air-purifying respirators (PAPR), as well as many other types of devices and equipment. These sensors are capable of detecting a broad range of gases, and can be tailored in versatile combinations of detection limit, response times, and power consumption.

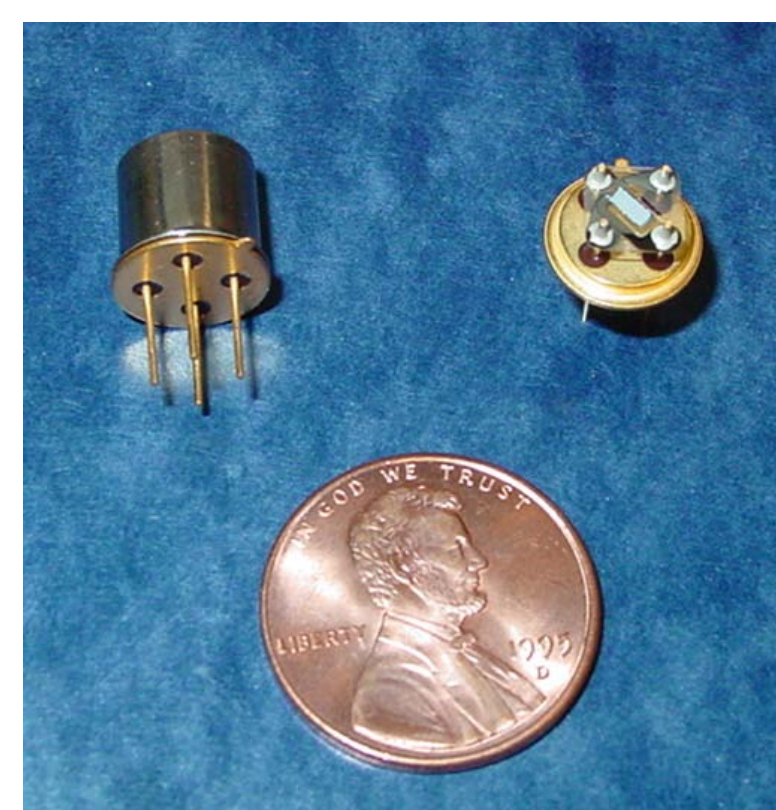
This poster describes the form and function of MikroKera™ sensors and offers examples of integration with PPT.

Introduction

- A key limiting factor in the development of improved personal protective equipment is the large size and power consumption of conventional sensor technologies. Synkera addresses this need through development of advanced sensors based a **unique MEMS technology**.
- Sensors are required that combine **high sensitivity and reliability**.
- Sensors must withstand challenging environmental conditions (e.g. temperature and humidity).
- **Size and power consumption** are critical challenges in the integration of sensor technologies with personal protective equipment and related devices.
- Under its MikroKera™ brand and technology, Synkera has developed several sensing platforms that can be used to make **measurements of a wide range of hazardous gases**.
- Some key features of MikroKera™ sensors are simple, solid-state design, robustness to environmental conditions, very low power consumption, and compatibility with a variety of small packaging options.



Microhotplates of two designs (400mW & 50mW @ 500°C)



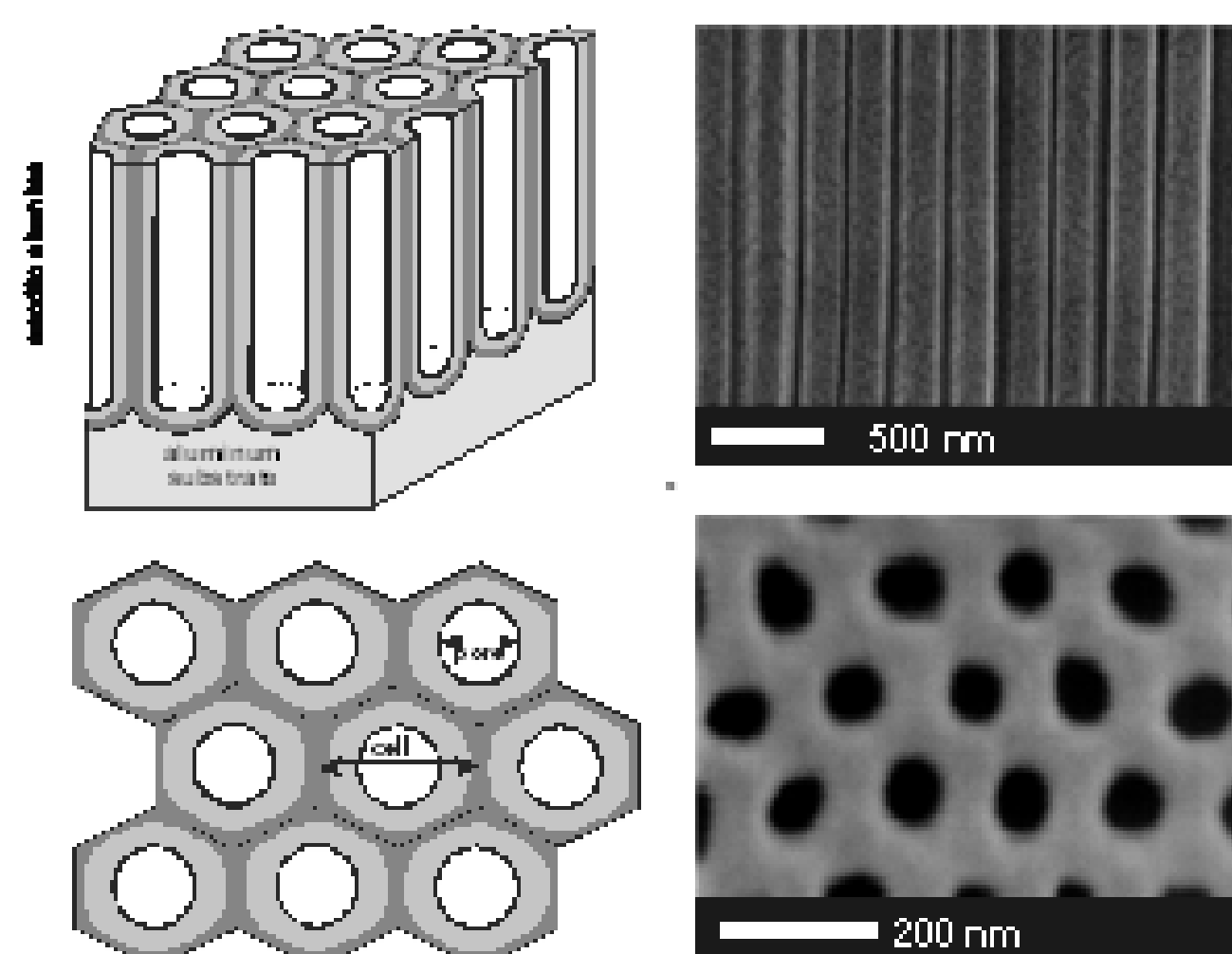
Packaged microsensors



Alternative designs & packaging

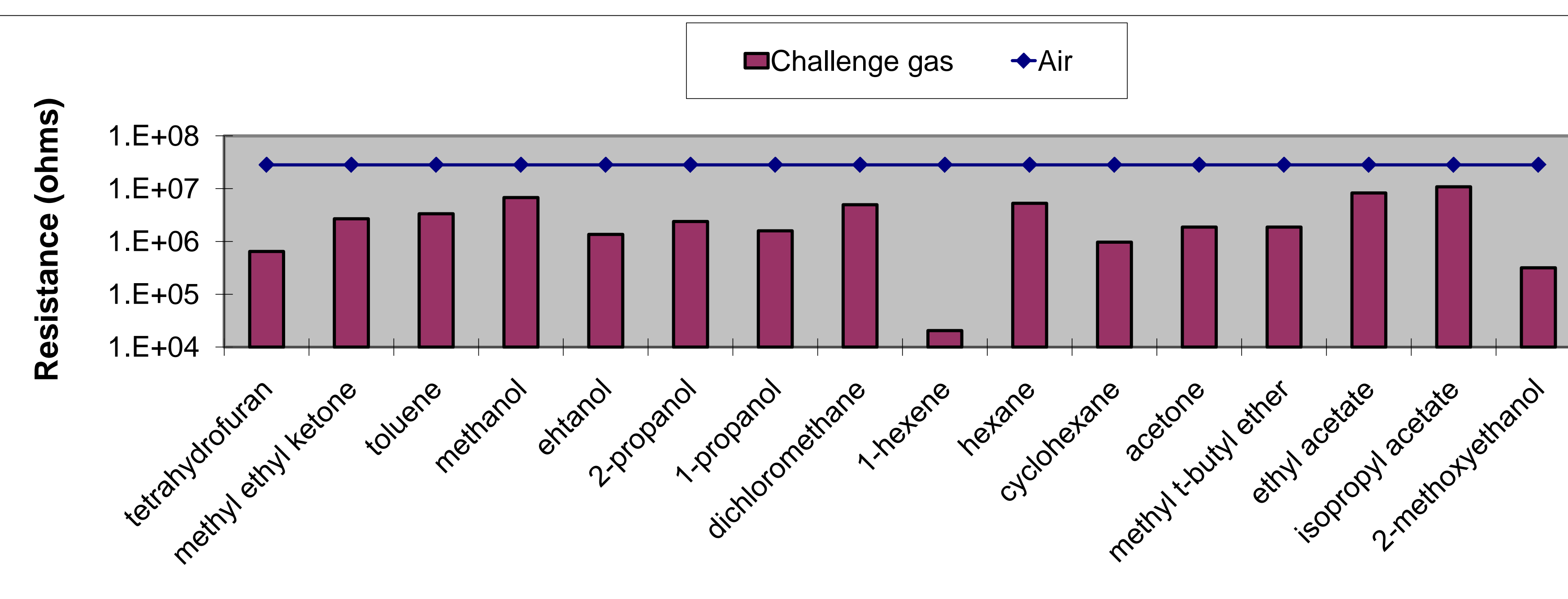
Method

- **The Platform:** Ceramic MEMS components, featuring unique nano-scale architecture, are used as substrates for chemiresistive and catalytic (pellistor) sensing.
- Anodization of aluminum foils under precisely controlled conditions results in the formation of a nanostructured porous architecture:



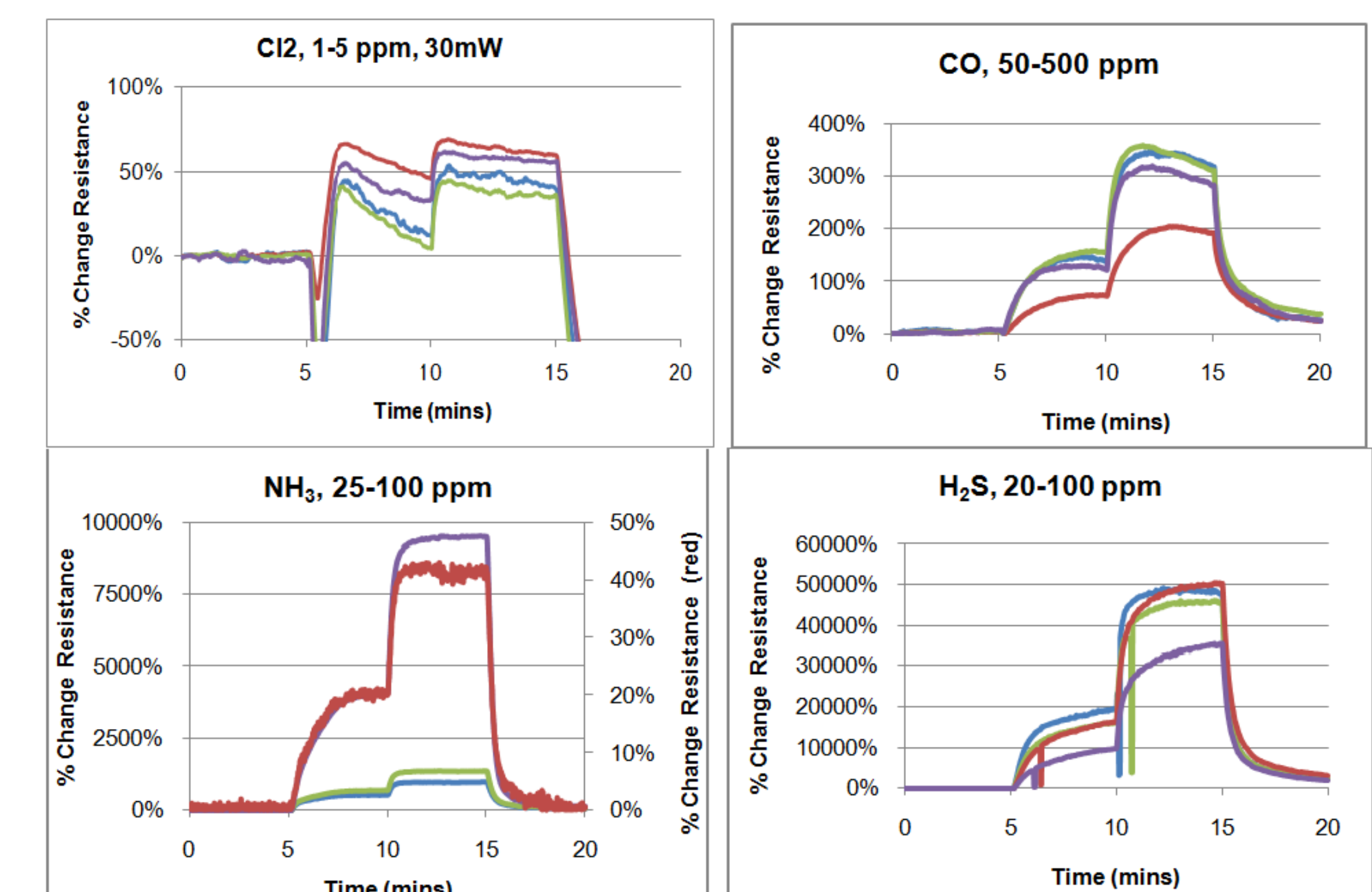
- Pore diameters are controllable over the range of 5 to 300 nm.
- Ceramic micromachining of the nanoporous substrate creates a MEMS heater for use as a chemical sensing platform.
- Application of sensing materials to the pores of the ceramic provides a high surface area host for sensor interactions with the environment.
- **Chemiresistor sensors**
 - Built on ceramic MEMS hotplate → ultra-low power consumption.
 - Fast temperature pulsing further reduces power consumption.
 - Low power also enabled via advances in materials that allow reliable operation at lower temperatures than conventional semiconductor sensors.
 - Sensing based upon polymers and mixed metal oxides.
 - Material structure tailored at the nanoscale through *in situ* fabrication.
- **Catalytic combustible (Pellistor) gas sensors**
 - Build on ceramic MEMS heating filaments (see image to left)
 - High surface area of nanoporous architecture enable enhanced sensitivity and stability of sensing materials.
 - Currently under development with Phase II SBIR funding from NIOSH.

Broad VOC response (targeted at SLI) at 100 ppm of various compounds

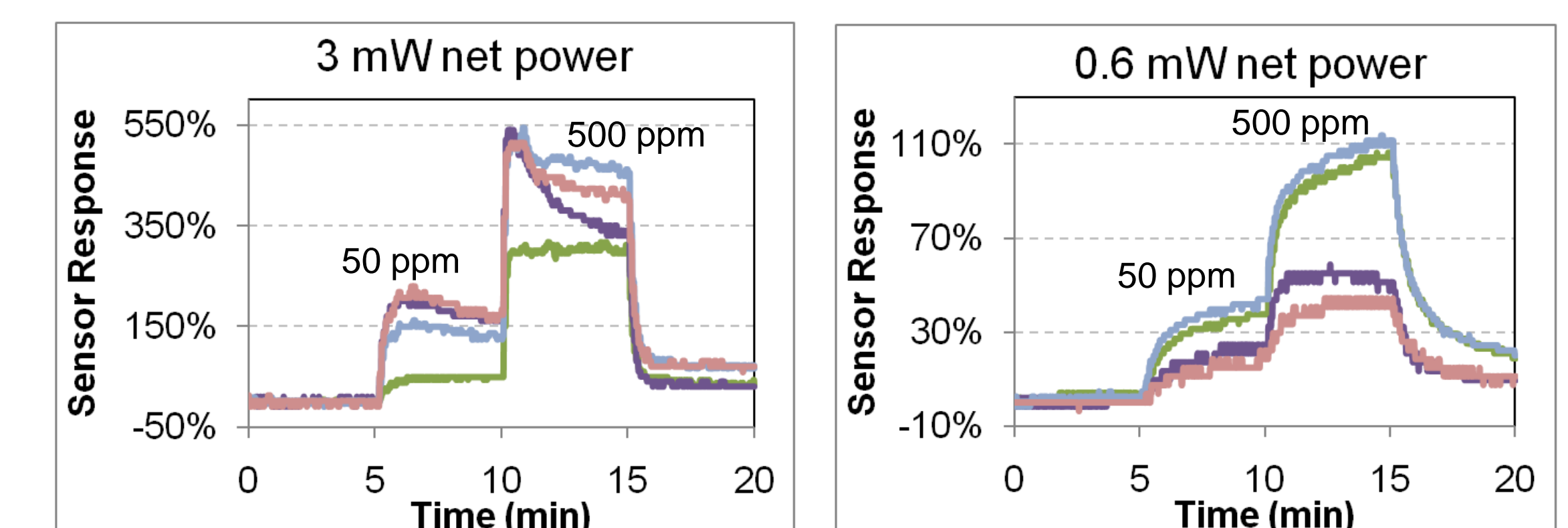


Results

- **Can detect a large range of gases**
 - VOC's
 - Acid gases (Cl₂, etc.)
 - Bases (Ammonia/Methylamine)
 - Flammable gases (H₂, CH₄, etc.)
 - Toxic gases (CO, TICs, CWAs, hydrides, and many others)
- **Fast response times**
- **Low detection limits (ppb level) demonstrated.**

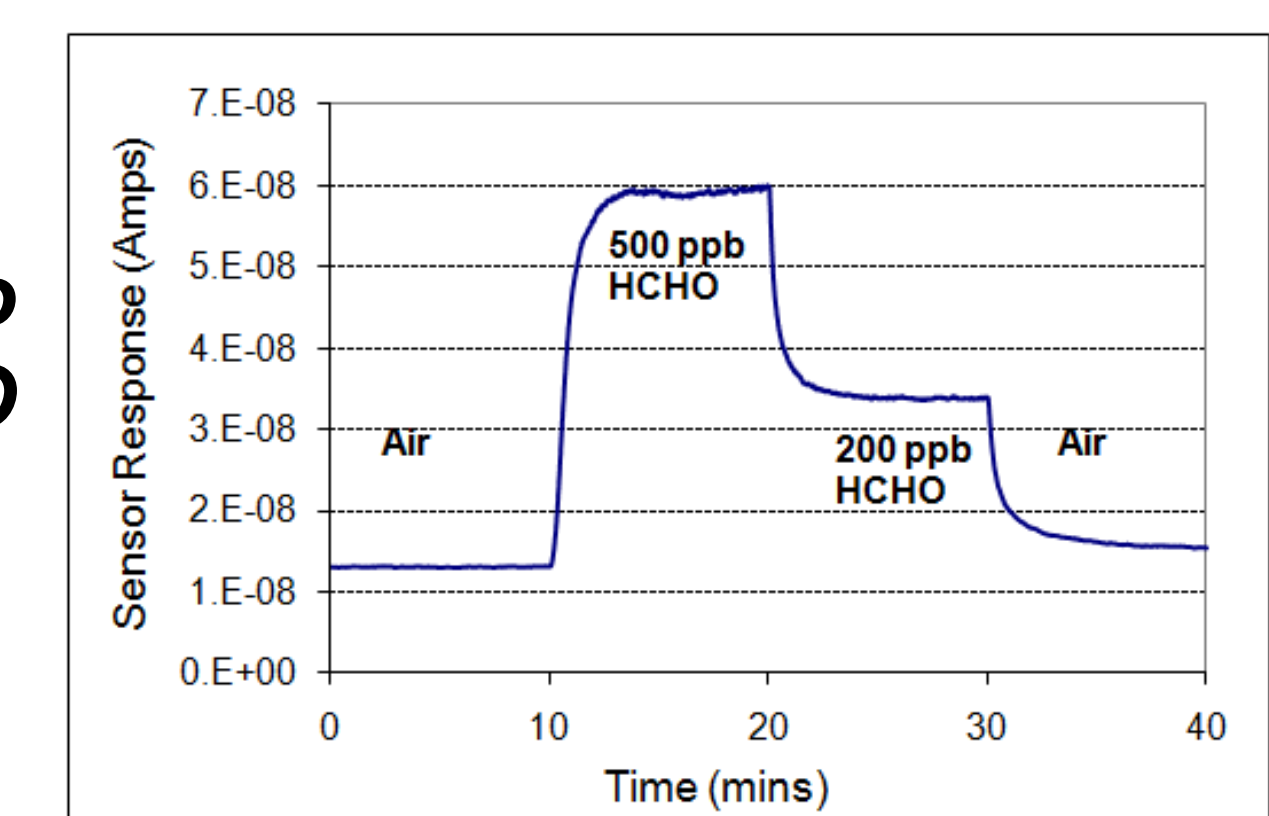


Sensors operating at 30mW continuous power above



Response to CO with pulsed powering above

Response to sub-ppm HCHO



Conclusions

- Ultra small, inexpensive broad band sensors enable SLI in respirators.
- Ultra small, inexpensive sensors enable redundant sensing for improved performance and reliability at instrument level.
- Ultra small, embeddable sensors enable advanced gas detection in a variety of new and existing PPE and other devices.
- The sensors are robust, capable of detecting a broad variety of chemicals, and can be customized to meet the needs of many PPT and related applications.